amount to less than 15 per cent under ordinary weather conditions, differences due to winter rainfall apparently amount to 10 per cent, and those due to rising and falling temperatures appear to amount to as much as 18 per cent. To determine either of the last two, the first must be eliminated. Glenn's Friez hygrothermograph readings of temperature and humidity were taken from the original sheets on the even hours. Such records are essential to the application of such a chart in practical prediction of the time of application sprays. The chart has the advantage of taking into account two factors instead of one factor and of being less likely to fail in years of extreme abundance of the pest, than the simple sum of temperature which can not even take account of the various relative effect of temperature at the higher and lower values.

In connection with this study several other uses for continuous records of temperature and humidity and some general characteristics of the daily march were made out.

Figure 2 shows the daily march of temperature at Olney, Ill. in 1915 and 1917. From 2 p. m. to 12 m. of the following day. In a general way the relative humidity changes much as does air with a fixed amount of humidity when warmed. Some days, as for example, April 23, 1924, show a higher relative humidity as the temperature goes up than does heated air due to evaporation from soil and plants. An occasional summer day, as e. g., July 27, 1928, shows a relative humidity lower than is to be expected at the higher temperatures. Rainy days as May 27, 1928, show a small range of relative humidity.

In preparing for experiments it is necessary to have the average daily march over various portions of the growing season determined to suit the plants or animals being considered. Where constant temperature experiments are to be set up, they should fall on the average daily march at the several temperatures used. The use of several temperatures at a fixed relative humidity is not a desirable method to follow because it greatly increases the number of experiments to be run. The average daily march for various periods was worked out by averaging the relative humidity at each temperature taking a period in the growing season which is of significance for the form being studied (Fig. 3.) This April 12 to June 12 covers the usual period of maximum numbers of codling moths in the pupal stage. The low average humidities for 1915 as compared with 1916, at the low temperatures, are shown by an inspection of the hygrothermograph sheets to be correlated with a sharp rise in temperature during the morning hours, probably due to a clear atmosphere. The months of July and August in 1916 showed considerable difference from 1915 both in temperature and average humidity at the same temperatures. Nineteen-sixteen was a year of extremes.

Experiments should have several years of hygrothermograph records at hand for the locality in which plants and animals are to be studied. The writer has found, however, that the United States Weather Bureau has recently stopped using these instruments quite generally. They should be in service in as many stations as possible because the use of the reciprocally operating factors in combination makes possible the evaluation of other factors. (Shelford 1927 and 1929.)

The scale used in diagrams such as are presented here is the one used in all the two dimension diagrams made in the author's laboratory. They have been based upon 5° C. equals (in actual scale distance) 50 millimeters rain or 20 per cent relative humidity. Accordingly, 9° F. equals (actual scale distance) 2 inches precipitation and 20 per cent humidity. This makes possible the plotting of weather data from either Fahrenheit or centigrade. Diagrams on different scales can not be readily compared without redrawing.

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A TROPICAL CYCLONE IN SOUTHERN CALIFORNIA [1]

551.515 (213) (794)

By DEAN BLAKE

[Weather Bureau Office, San Diego, Calif.]

Receipt of weather maps issued at Mexico City for the period September 10 to 18, 1929, enables us to trace the approximate path taken by the storm that appeared unheralded over extreme southern California on the morning of September 17, and to substantiate the conviction that the abnormal weather conditions that occurred at that time were the result of a tropical cyclone that moved northward along the west coasts of Mexico and Lower California.

On the afternoon of September 16 a remarkably dry, desiccating hot wave, which apparently was moving westward, was reported from the valleys in San Diego County back from the coast. The first word came from El Cajon, about 14 miles inland, where temperatures considerably over 100° were being experienced. As the afternoon advanced, alarmed citizens, who associated the heat with brush fires burning in the hills, telephoned from points progressively nearer the city, and near 4 p. m. temperature contrasts between the downtown sections of San Diego and the surrounding hills became very marked. It was about this time of the day that exceptionally high maxima were registered in the county, El Cajon reporting 111°, Escondido 107°, and Ramona 102°, these temperatures being accompanied by strong easterly winds.

At the station the winds were light to gentle and from the west and northwest, and the relative humidity only slightly below normal. Two miles away, however, strong easterly winds and abnormally low relative humidities were reported, and many people who experienced the change between the two currents commented upon its suddenness and abruptness, the line of demarcation being sharply defined.

It was not until 4 a. m., 12 hours later, that the hot wave finally reached the San Diego station, but when it did the temperature rose suddenly from 70° to 94° in less than 30 minutes, and there was a decrease in the relative humidity to 16 per cent. The maximum temperature for the day, 95°, occurred at 7:30 a. m. after which hour the temperature slowly decreased, due to the increasing cloudiness and later to the rainfall. Although at sundown the night before the sky was cloudless and the relative humidity was 72 per cent, at 8:55 a. m. a sprinkling rain began with a relative humidity of only 38 per

[1] *Cf.* Hurd, W. E., This REVIEW, vol. 57: 397–8.

cent. This rain continued with varying intensity until 8:20 p. m., the total recorded being 0.21 inch.

As far back as data extend there is no record of such abnormally high morning temperatures as occurred over southern California on the 17th. At the time of the readings, 4:40 a. m., San Diego reported 93.3°; Los Angeles, 90.3°; and the thermographs at El Cajon, Bonita, and Escondido showed 91.4°, 91.9°, and 92°, respectively.

We now know that these record temperatures and widely contrasting conditions were occasioned by the approach of a tropical cyclone that formed somewhere over the Pacific Ocean off the Mexican coast. Hurd has shown in his discussion, Tropical cyclones of the eastern north Pacific, reprinted on the backs of numerous editions of Pilot Charts, that such storms are by no means infrequent; that they attain great force, and sometimes move northward along the coast, recurving over northern Baja California or southern California.

For several days previous, dynamically heated winds prevailed over southwestern United States, due to an anticyclone of moderate intensity that was crested over the Plateau region, and a low barometric system over the Pacific slope. However, it was not until we could chart the movements of this Pacific cyclone that we were able to explain the causes that gave rise to the apparently inexplicable phenomena of rain with very low humidity and temperatures which were obviously the result of adiabatic heating.

The following translations of those portions of the Mexican maps that refer to this cyclone are illuminating:

September 10.—There are indications of a cyclonic disturbance to the south of the Isthmus of Tehuantepec which will probably cause bad weather between Sa'ina Cruz and Manzanillo.

September 11.—There are still indications of a cyclonic disturbance to the southwest of the port of Salina Cruz.

September 12.—To the southeast (? sureste) and near Acapulco indications of a cyclonic disturbance continue.

September 13.—To the southwest and near the port of Acapulco is located the cyclonic disturbance which has caused bad weather recently, and it is probable that it will move toward the region south of the Gulf of California.

September 14.—South of Manzanillo is found the cyclonic disturbance of the Pacific which appears to be moving toward the northeast.

September 15.—For lack of precise data it is not possible to know the position of the cyclone over the Pacific.

September 16.—The Pacific cyclone is found to the west and very near Mazatlan being probably between the land to the north and said port.

September 17.—We have no data of the Pacific cyclone, but the weather is becoming better rapidly in the region south of the Gulf of California.

September 18.—The cyclonic disturbance of the Pacific, almost dissipated, is found to the west of San Diego, Calif.

Gales and heavy rains occurred on the coast, and winds of hurricane force were reported at Manzanillo, Acapulco, and Mazatlan during the period from the 10th to the 14th.

A table showing the hourly changes in temperature, wind velocity and direction, and rainfall at San Diego and Los Angeles on the 17th, when the storm passed over southern California, is available for reference. Two days later the storm had completely disappeared.

The rainfall on the coast was light, but torrential falls occurred locally at points in the mountains, and considerable damage to property resulted.

SLEET AND SNOW AT UNUSUALLY HIGH TEMPERATURES

551.524 : 551.578.4 (764)

By J. P. McAULIFFE

[Weather Bureau Office, Corpus Christi, Tex.]

An unusual phenomenon occurred at Corpus Christi, Tex. November 14, and was repeated on a smaller scale November 20, the occurrence of sleet and snow with the surface temperature above 50°.

Sleet began falling at 8 p. m. November 14, and continued intermittently until 10 p. m. The measured precipitation resulting from this sleet was nearly 0.004 of an inch. Several rather heavy showers of sleet fell during the 2-hour period, 8 to 10 p. m. The writer examined the sleet carefully, and there was no doubt that it was genuine sleet. Pellets remained unmelted for a few minutes after falling.

During the entire time this sleet was falling the surface temperature was above 50°. Temperature at 6:40 p. m. was 53°, after which there was a gradual fall to 50° at midnight. The sleet fell from alto-stratus clouds moving from the west. The surface wind was from the northwest.

Another slight fall of sleet and snow occurred during the morning of November 20. Snow fell in large flakes from 10:30 a. m. until 10:33 a. m., and sleet fell from 11:30 a. m. to 11:34 a. m. Surface temperature during the time of this fall was never below 57°, ranging from 57° at 6:40 a. m. to 58.5° at noon. The precipitation came from stratus clouds moving from the north-northeast. The surface wind was from the north.

The explanation of these unusual phenomena seems to be that a stratum of freezing air overspread Corpus Christi at the time of sleet and snowfall. In the case of the sleet November 14 the air at the altitude of the clouds must have been above freezing, while below this level considerably below freezing existed, and this layer of subfreezing air was probably not more than 1,000 feet above the ground.

DISCUSSION

It seems most likely that the sleet and snow at Corpus Christi was the result of a cold current aloft but at a considerably higher altitude than that suggested by Mr. McAuluffe, viz, 1,000 feet above the surface. Freezing temperatures at that height would have caused an extremely steep lapse rate (3° C./100 m.) which is not probable. The Groesbeck kite flight of November 14 shows a very variable lapse rate with temperatures around the freezing point from the surface to 2,525 m. above sea level. It would seem more probable that the sleet and snow at Corpus Christi came from a rather high elevation and evidently reached the surface before melting due to the near freezing temperatures encountered. Mr. H. L. Choate of the aerological division suggests the probability of the cooling effect of the evaporation of some of the snow and sleet as making it possible for the remainder to reach the ground. He recalls a similar condition at Drexel where sleet and snow fell, and the temperature to 3,800 m. remained above freezing.—*L. T. Samuels.*